# The Role Of Wood-Decaying Fungi In The Carbon Cycle Of Forest Ecosystems And The Main Ecological Factors

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## Abstract

Some climatologists accept that recent climate warming is largely due to an increase in atmospheric concentrations of greenhouse gases such as carbon dioxide, methane, and nitric oxide. For this reason, studies on identification and analysis of the sources of these gases are gaining momentum. Decomposition of wood and oxidative conversion of organic carbon into $CO_2$ carried by myco-bacterial community, in which the leading role played by fungi of the Department Basidiomycota (wood-or xylotrophic Basidiomycetes). It is organisms capable to solid-state fermentation of lignocellulosic wood complex. The role of xylotrophic basidiomycetes in biosphere currently undervalued and many aspects of ecology of these organisms are low-or not at all known. In particular, insufficiently the data about intensity of decomposition of timber, thus the conversion of organic carbon of wood into carbon dioxide pool in vivo. The external manifestation of these processes is the $CO_2$ emissions, the activity of which is a measure of the intensity of decomposition of wood and conversion of organic carbon by fungi. The results of the study allow us to understand the role of xylotrophic basidiomycetes in the biosphere. This knowledge is needed to predict the carbon cycle of forest ecosystems under climate change and human impacts on the forest biota.

**Keywords:** Carbon cycle, climate change, forest ecosystems, wood-decaying fungi

## Introduction

The carbon cycle of forests and their C-CO2 gas exchange with the atmosphere is based on the reduction of atmospheric CO2 conversion into organic carbon, deposited in the wood, and the oxidative conversion of organic carbon into CO2 from the decomposition of wood (Mukhin, Voronin, 2007). Due to these processes, the forests are the regulators of the balance of C-CO2 in the atmosphere and play an important role in the biotic Earth's climate regulation (Baumgartner, 1979; Cannel, Milne, 1995; Kudeyarov et al, 2007).

Wood is the main carbon reservoir in forests. Carbon returns back to the atmosphere in result of decomposition by special group of organisms – wood-decaying fungi. Under natural conditions, decomposition of dead wood is mainly performed by basidial fungi, which are the only known group of microorganisms capable of biological conversion of all wood compounds. In this work, we showed that wood-decaying fungi play a very important role in global cycle and budget of $CO_2$. Changes in climate will modify the fungal complexes and it can lead to a misbalance between the photosynthetic store and the emissions of greenhouse gases and accelerating the climatic changes. The study of the influence of humidity and temperature on the conversion activities of fungi makes it possible to identify those factors related to different types and simulate their response to climate change. The results obtained show, that conversion activity of wood-decaying fungi depends on the humidity, and ambient temperature, degree of decomposition of the wood substrate and physiological types of fungi.

The aim of this works is study of ecological and physiological characteristics and conversion activity of wood-decaying fungi in forest ecosystems. In this revie we combined the results of many years of research into the carbon conversion activity of wood-decaying fungi under natural conditions.

## Material and methods

For experiment were taken fragments of wood the affected by wood-decaying fungi (370 samples were analyzed). To assess the $CO_2$-emission activity of fungi used gasometric approach - a portable gas analyzer ($CO_2$ / $O_2$) produced by "Microsensor technique", Russia. $CO_2$ measurement error of ± 20 ppm, $CO_2$ measurement error of ± 0.2 %. The samples were exposed in sealed glass jars (0.27 - 9.0 l). The exposure time was varied for different experiences from 3 hours to several days (the study of seasonal dynamics). The glass jars were kept during the experiment at 20±1 °C. To determine the absolute dry weight of the samples were dried for 72 hours at 105 ° C. The temperature and humidity measured by Datalogger CEM (the temperature measurement error of ± 1 °C, humidity error ± 2%).

## Discussion

According to our data (Fig. 1), the $CO_2$ emission activity of woody debris is positively related to its moisture content and with increasing humidity by 10%, $CO_2$ emissions increased almost two-fold, reaching its maximum at 55-60%. Moisture content deciduous and coniferous debris were not significantly different, independent of the size, volume of wood debris and species of fungi. Humidity of wood debris has a weak dependence with a physiological type of fungi (higher in woody debris with white rot) and a close positive dependence with the destruction debris.

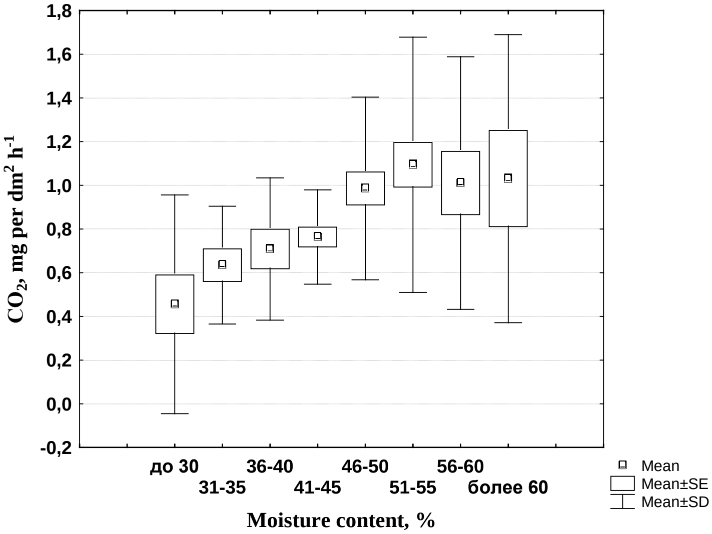


Figure 1. Moisture content of woody debris and $CO_2$ emission activity.

$CO_2$ emissions increases linearly with moisture content, reaching its peak at 55%. A further increase of moisture content up to 70% didn't appear to have any influence on the $CO_2$ emission activity which is achieved at its maximum level.

Also was evaluated intensity of moisture loss in natural conditions, which allowed establishing the dependence from the hydrothermal environment of the flow rate of gas exchange processes of wood-decaying fungi and wood substrates affected by them.

Shown, that the rate of loss of water rather strongly depends on external conditions such as the humidity and the temperature. However, it is the ambient humidity is an increasingly important factor. Therefore, it may be noted daily dynamics of studied process. The most active of loss of water (0.6 g per wet weight $day^{-1}$) is fixed in the daytime, when the average air temperature during the observation period was 20.47 °C, and humidity of 75.07% respectively; while at night, with an average temperature of 16.36 °C and humidity of 86.24%, the water loss was not observed at all or had very low (0.015 g per wet weight $day^{-1}$).

The rate of water loss from the samples destroyed by various types of fungi also varies. Under the same conditions will faster dry the samples having a small diameter (1.36 - 2.3 cm), the average intensity of transpiration of 0.18 g $H_2O$ per wet weight $day^{-1}$. Larger samples (4.37 - 6.31 cm) has the average rate of water loss is equal to 0.06 g $H_2O$ per wet weight day$^{-1}$. This is probably due to the fact that the samples of smaller volume wood and fruit body will react faster to changes in environmental conditions.

As for the respiratory activity of wood-decaying fungi, it may be noted how clearly defined its dependence on moisture content of the sample and poorly expressed.

Thus, it was found that the intensity of water loss of wood substrates affected by different kinds of wood-decaying fungi is directly proportional to temperature and inversely proportional to the ambient humidity, and the humidity being more significant factor. Respiratory activity also depends on the moisture content - with drying of the sample the rate of $CO_2$ exchange is reduced.

According to the annual cycle of temperatures in the Urals, the seasonal dynamics of the conversion activity of wood-decay fungi has a four different duration periods: spring, summer, autumn, winter. In autumn the respiratory of fungi exchange was recorded before the beginning of November, and its activity was average 0.15 mg $CO_2$ per g (dry weight) day$^{-1}$. The middle of November, with the onset of stable negative temperatures, the emission of $CO_2$ has stopped, that indicating the stop of the respiratory activity of fungi. In a state of physiological rest of the winter fungi stayed until the end of March, when they had registered a weak respiratory activity of 0.07 mg $CO_2$ per g (dry weight) day$^{-1}$.

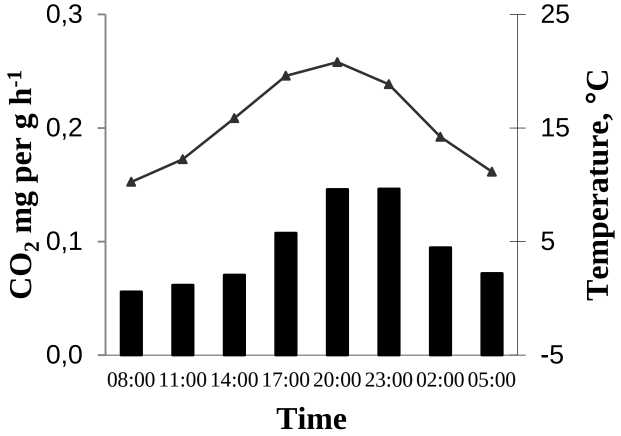


Figure 2. Daily dynamics of respiratory activity of *Fomes fomentarius* (L.) Fr.

In accordance with the process temperature (Fig. 2), maximum activity was observed in the evening hours when the air temperature was 30.3 °C, the minimum - in the night and morning hours (T = 17-20 °C).

Thus, it can be concluded that the temperature is an important factor in determining the seasonal dynamics and intensity of life of wood-decaying fungi: respiration rate, and thus the conversion of organic carbon into $CO_2$, is directly proportional to the ambient temperature. This allows you to estimate $CO_2$-emission wood-decaying fungi activity on the basis of temperature characteristics.

## Conclusion

Shown that the humidity and temperature are the most important factors of $CO_2$-emission activity, but its main determinant is temperature. On the one hand was detected high dependence between $CO_2$-emission activity and humidity and on the other hand - dependence between degree of destruction and moisture content of woody debris.

Thus, knowledge of the gas environment is necessary to determine the capacity of acceleration or deceleration of decomposition of wood in the forest. The determination the rate of gas exchange, as well as the major factors affecting the $CO_2$-emission activity of wood-decay fungi will help clarify the ecological role of fungi in forest ecosystems.

## References:

Baumgartner, A. (1979). Climate Variability and Forestry. World Climate Conferences: A Conference of Experts on Climate and Mankind, Geneva, WMO.

Cannel, M.G.R., Milne, R. (1995). Carbon pools and sequestration of forest ecosystems in Britain: *Forestry 68* (4), 361-378.

Kudeyarov, V.N., Zavarzin, G.A., Blagodatskii, S.A., et al. (2007). Puly i potoki ugleroda v nazemnykh ekosistemakh Rossii (Carbon Pools and Fluxes in Terrestrial Ecosystems of Russia), Moscow: Nauka.

Mukhin, V.A. and Voronin, P.Yu. (2007). *Ekologiya 1*, 24–29.